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The World of NDE 4.0:
Let the Journey Begin

Ripi Singh
Johannes Vrana
Webinar May 05, 2020

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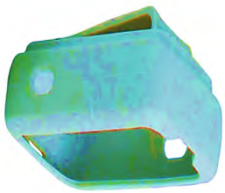
Story

First Article – Digitization of Metrology Inspection

- Before
  - *Coordinate Measuring Machine*
  - *SPEND – 4 hours, 2.5 man-hours*
  - *GET – 120 Critical Data Points*
- After
  - *Digital Scanner*
  - *SPEND – 1 hour, 1 man-hour*
  - *GET – Full profile, Point cloud*



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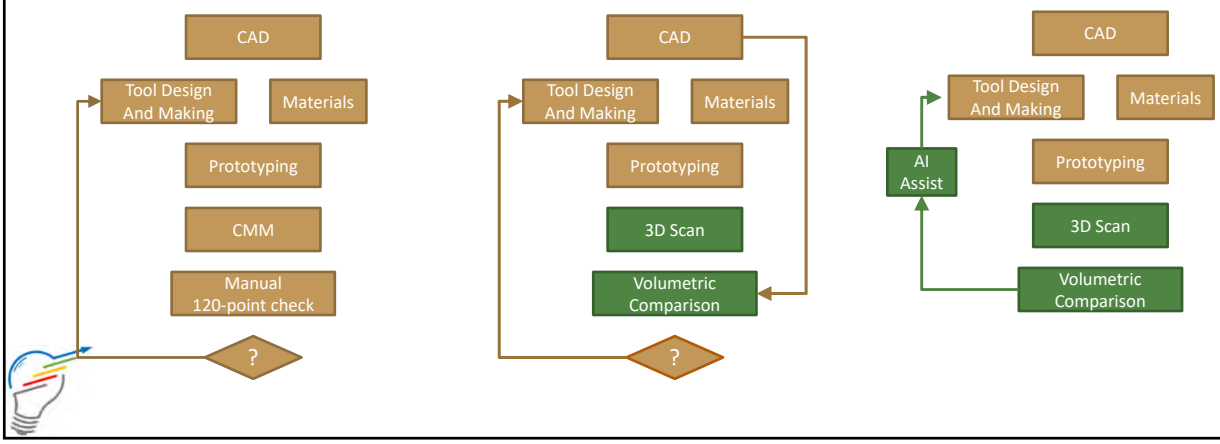
Story

First Article – Digitalization of FAI Process

- Before
  - *7 Days, 24 man-hours*
  - *2-3 Tool re-design*
- After
  - *1½ Day, 6 man-hours*
  - *1 Tool re-design*
- Future
  - *1 Day, 2 man-hours*
  - *No Tool redesign*



TOC

Outline

- *Define* — *How do we define the generations of NDE ?*
- *WHY* — *Why should we care for NDE 4.0 ?*
- *WHAT* — *What is the technical magic under the hood ?*
- *HOW* — *How do you create a robust roadmap ?*

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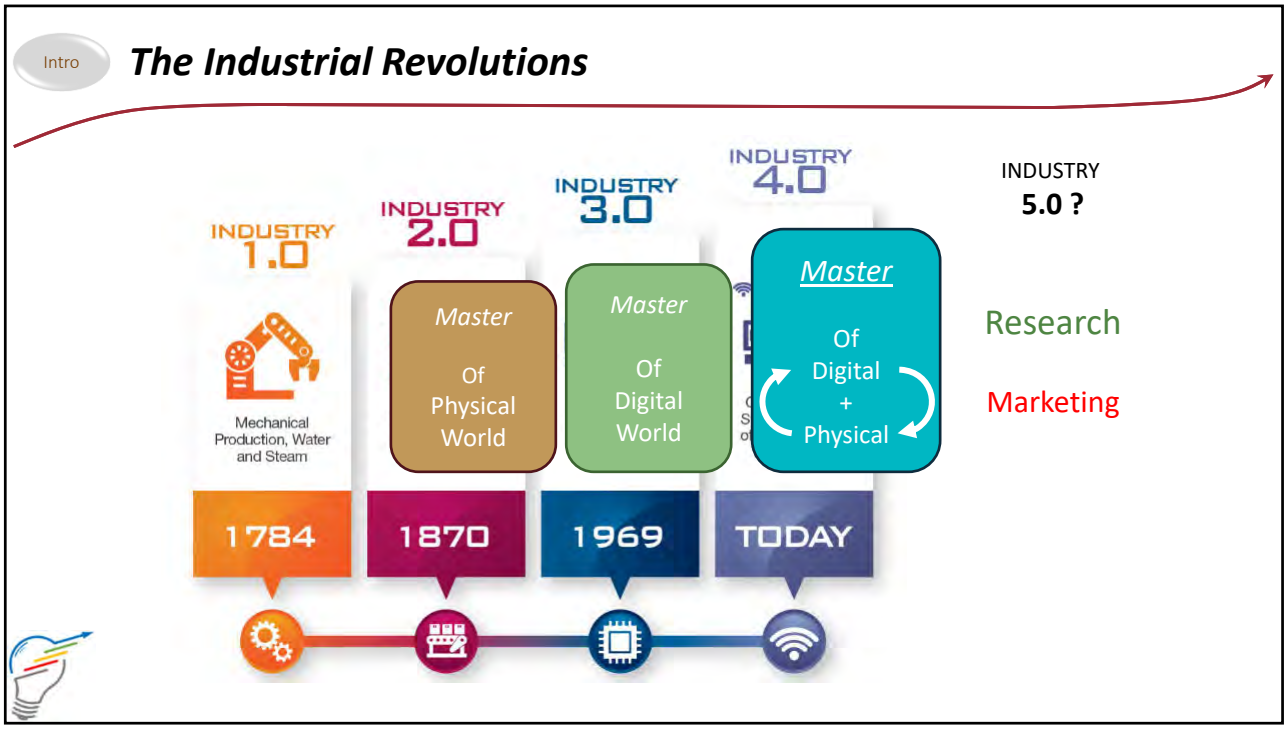

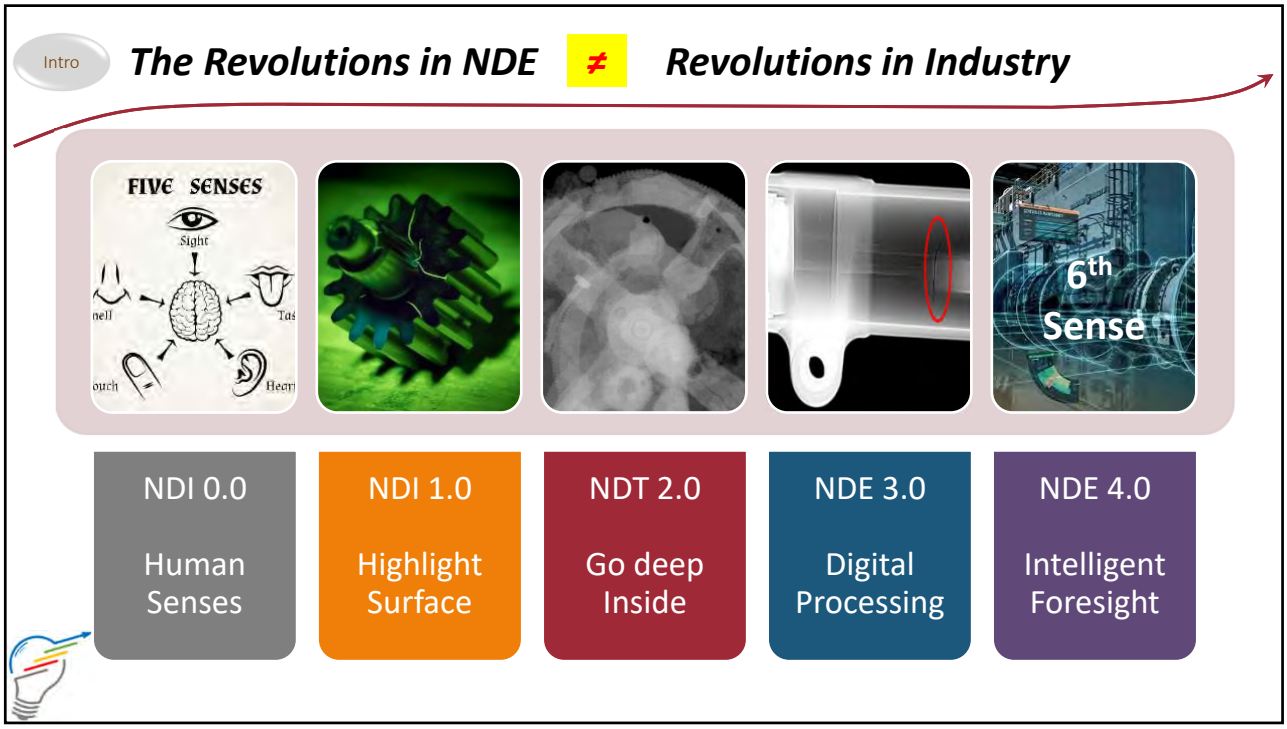

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What

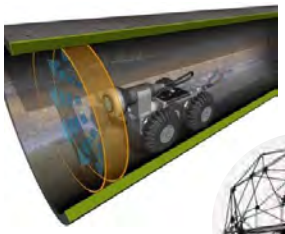
Industry 4.0 – Growing Technology Portfolio

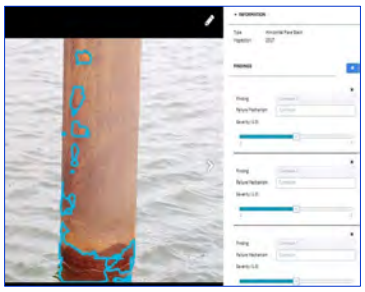
This list is Always incomplete

- An inspection may use one or more of these
- NDE 4.0 Eco-system will use all of them somewhere or the other

Example

Some Familiar things – Are they NDE 4.0 ?





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Ref

Proposed Definition – Full

(What) *Cyber-physical Non-Destructive Evaluation (including Testing)*;

arising out of a

(How) confluence of industry 4.0 digital technologies, physical inspection methods, and business models;

to

(Why) enhance inspection performance, integrity engineering, and decision making for safety, sustainability, and quality assurance,

as well as provide relevant data required to improve design, production and Maintenance

Ref

Proposed Definition – Short

Mutual convergence of NDE and Industry 4.0 technologies

for social/safety, economy, and reliability.

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TOC

Outline

Define
- *How do we define the generations of NDE ?*
  - *Ability to see what was unthinkable before*

WHY
- *Why should we care for NDE 4.0 ?*

WHAT
- *What is the technical magic under the hood ?*

HOW
- *How do you create a robust roadmap ?*

What

Future … Prescriptive NDE of Individual Assets

"Cost Center" to "Value Creation"

Prescriptive Handling
- Do(s) and Don't(s)
- Maintenance/Repair
- 3D Printed spares/tools
- Edge Computing
- …

5G and More
NDE 4.0 Data (IOT)
- Relevant ~~Big~~ Data
- Digital Manufacturing
- In service inspections
- Data Connectivity
- …

Asset Knowledge
- Augmented Reality
- Simulation – Predictions
- Damage Progression
- Artificial Intelligence
- What if Scenarios
- …

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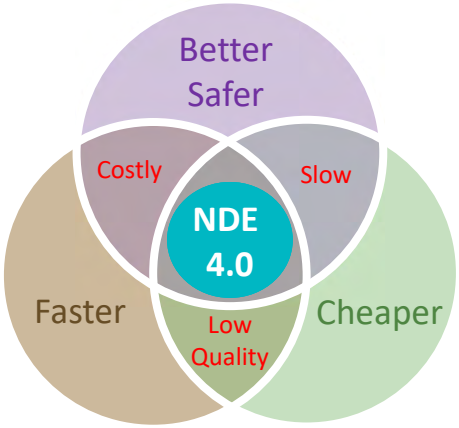
Why

WHY NDE 4.0 – Safety, Cost, Speed, Availability

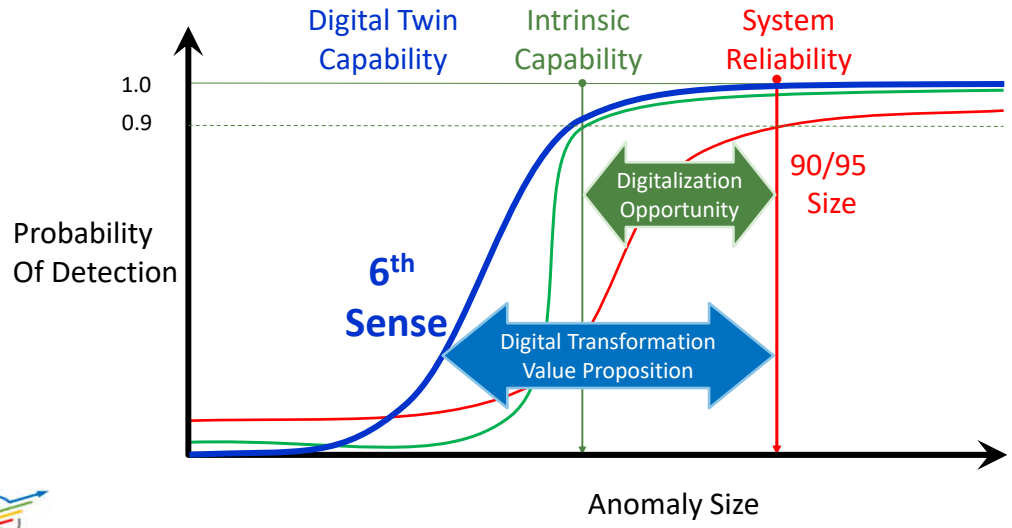
- Better (Safety as outcome)
  - *Improved reliability (POD) over lifetime*
  - *Better manufacturing quality*
- Cheaper (Cost)
  - *Replace man-hour cost with machine cost*
  - *Reduce consumables (Paper, Films, ….*
- Faster (Speed)
  - *Rapid scan, analysis, and interpretation*
  - *Potential for 24/7 operation*



- Opportunity for Sustainability and Business Resiliency

Why

BIG Opportunity from Adoption



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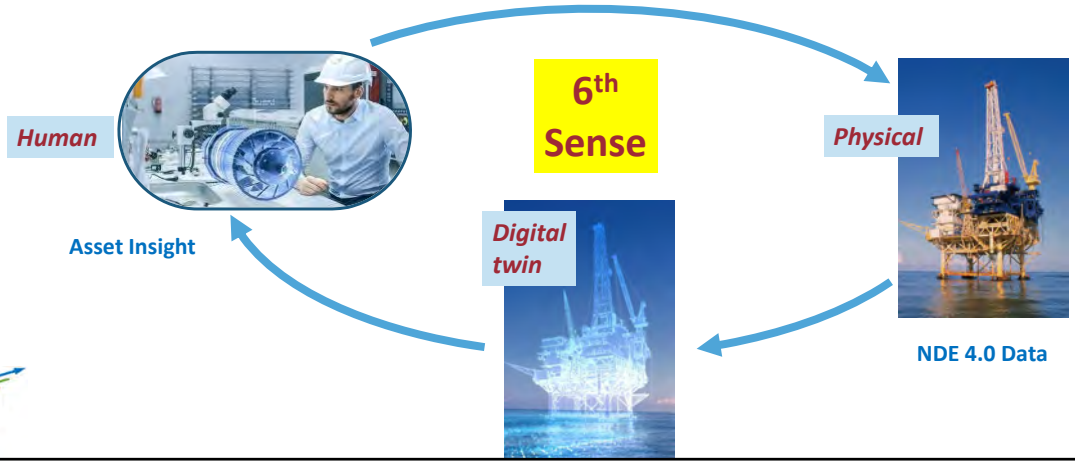
What

BIG Opportunity from Adoption

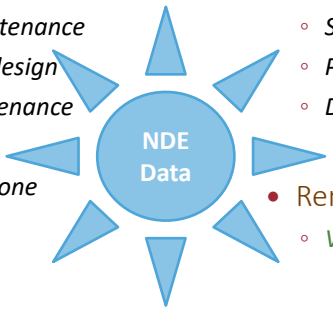
*"**Inspector in NDE 4.0 Eco-system**" will be able to detect an anomaly on the digital twin before the "**Inspector**" can pick it on the physical asset/instrument in today's system*



Why

WHY NDE 4.0? – Many more use cases !

- Industry 4.0 for NDE
  - *Enhance NDE capability & reliability*
  - *Workflow efficiency & effectiveness*
  - *Inspector Learning and certification*
  - *Improve inspector safety & support*
  - *Better NDE system maintenance*
  - *Improving NDE system design*
  - *Prescriptive asset maintenance*
  - *Custom NDE solutions*
  - *NDE simplified for everyone*
  -
- NDE Data for Industry 4.0
  - *Connected factory of the future*
  - *QA on shop floor & for aging infrastructure*
  - *Circular economy and sustainability*
  - *QA of 3D Printed – mass customization*
  - *Safety of drones and industrial robots*
  - *Product design improvement*
  - *Data monetization*
- Renewed respect for NDE Profession
  - *Value creator and not cost center*



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What

Summary of Why NDE 4.0

WHY
NDE 4.0

Safety Solutions

- Keep inspector away from harms way
- Reduce the risk of fatal system failure

Economic Value

- Optimize life cycle sustainment cost
- Use data to drive design improvements

TOC

Outline

Define

- *How do we define the generations of NDE ?*
  - *Ability to see what was unthinkable before*

WHY

- *Why should we care for NDE 4.0 ?*
  - *Take maintenance value proposition to the next level - prescriptive maintenance*

WHAT

- *What is the technical magic under the hood ?*

HOW

- *How do you create a robust roadmap ?*

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The World of NDE 4.0

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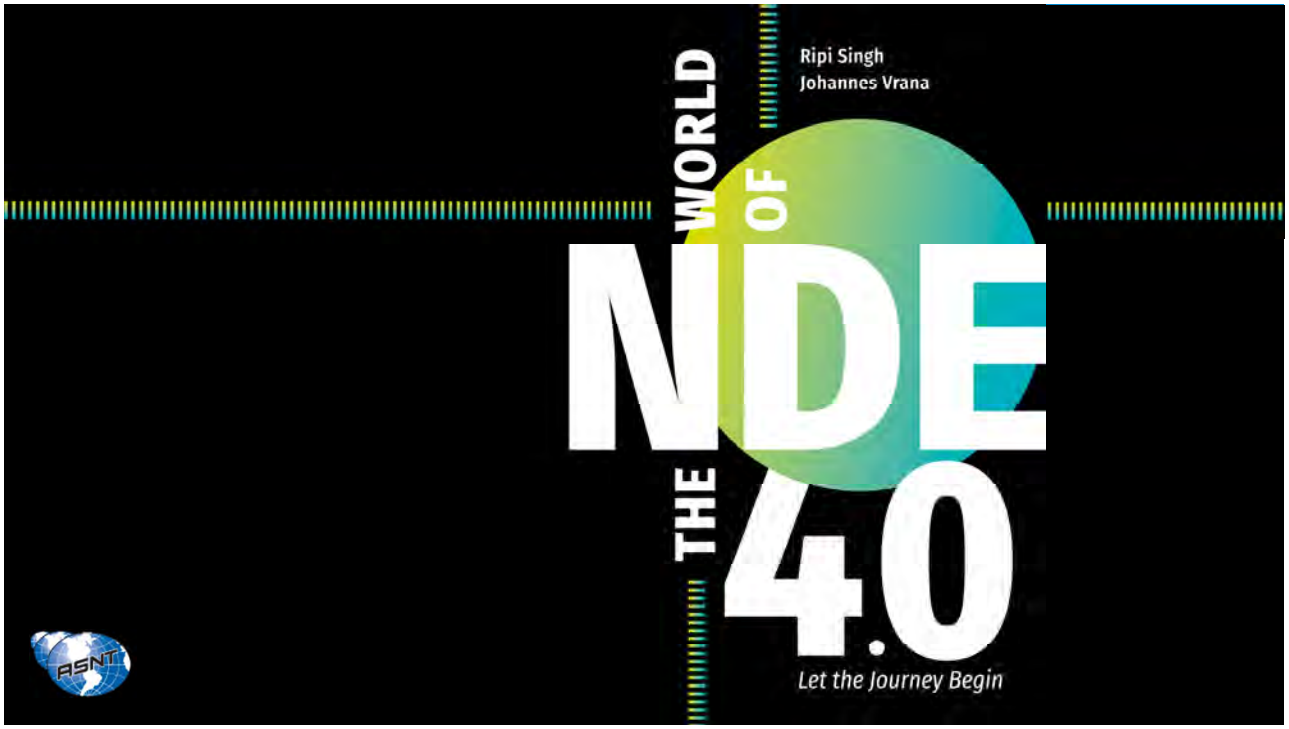

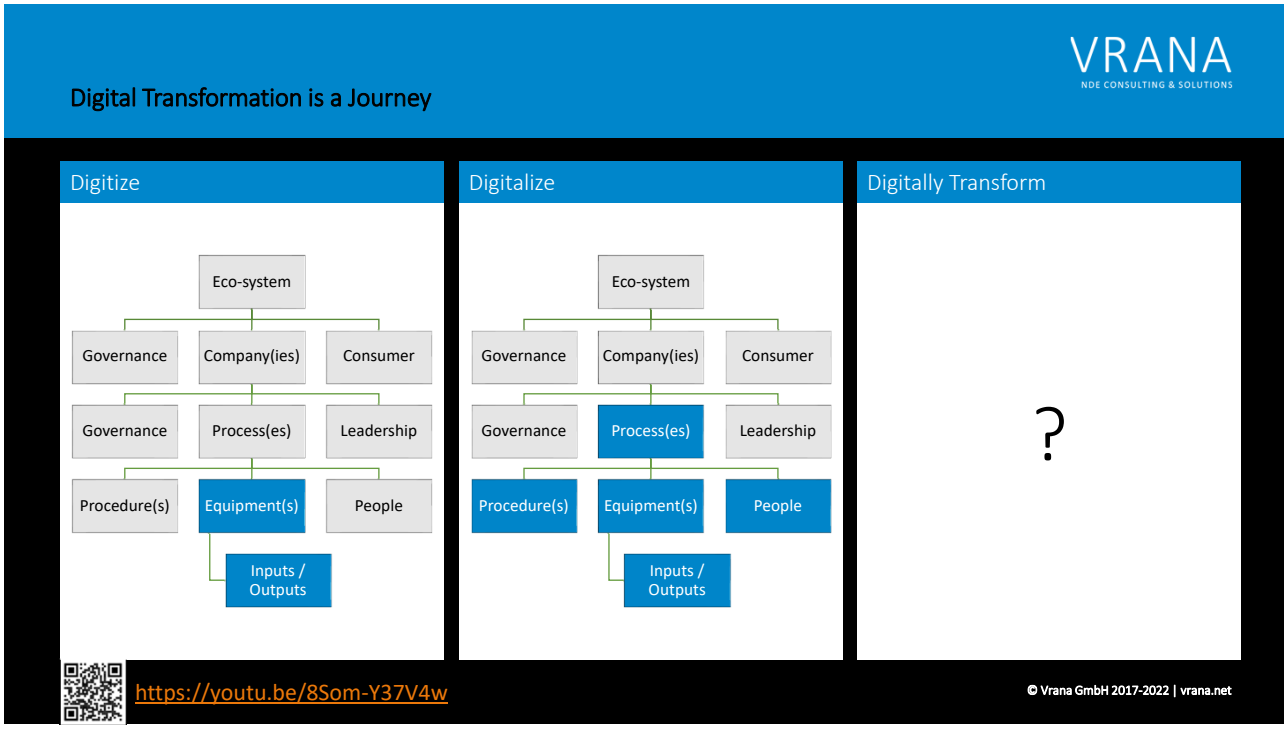

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Emerging Technologies

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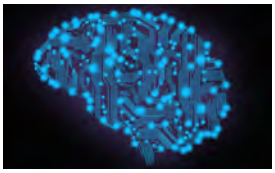
Extended Reality

Artificial Intelligence

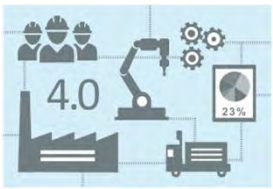


Robotics & Drones

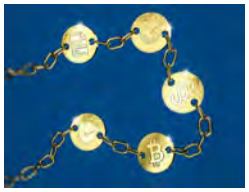
5G

Additive Manufacturing

IoT & Digital Twin



Blockchain



Quantum Computers

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NDE 4.0 Use Cases

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Enhancing NDE Methods by Emerging Technologies

Use of emerging technologies for NDE, like:

- Augmented reality
- Artificial Intelligence
- Robotics
- 5G
- Blockchain
- Digital Twin

Inspection Support

Remote Support

- Manufacturer
- Experienced Inspector
- Level III
- Engineer

Improving NDE Equipment

NDE system / equipment status

- Helps manufacturer to improve
  - Hardware
  - Software

Inspection Control 4.0

NDE Processes 4.0

- Digital Workflow
- Digital Commissioning
- Digital Supply Chain Processes

Component traceability

- Revision-safe documentation
- Result retrievability

Life Cycle Record

- Result Statistics
- Reliability

Performance Statistics

- Value of the inspection
- Inspection performance
- Training status

Industry 4.0 for NDE

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Challenges

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» NDT does not have any value at all.
It only sorts out parts, that in reality are good.
I don't want it and I would never ever do it, but my customer insists on it.
I'd prefer spending the money into further improvement of my production! «

https://youtu.be/hX45ynpkl8k

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Archiving

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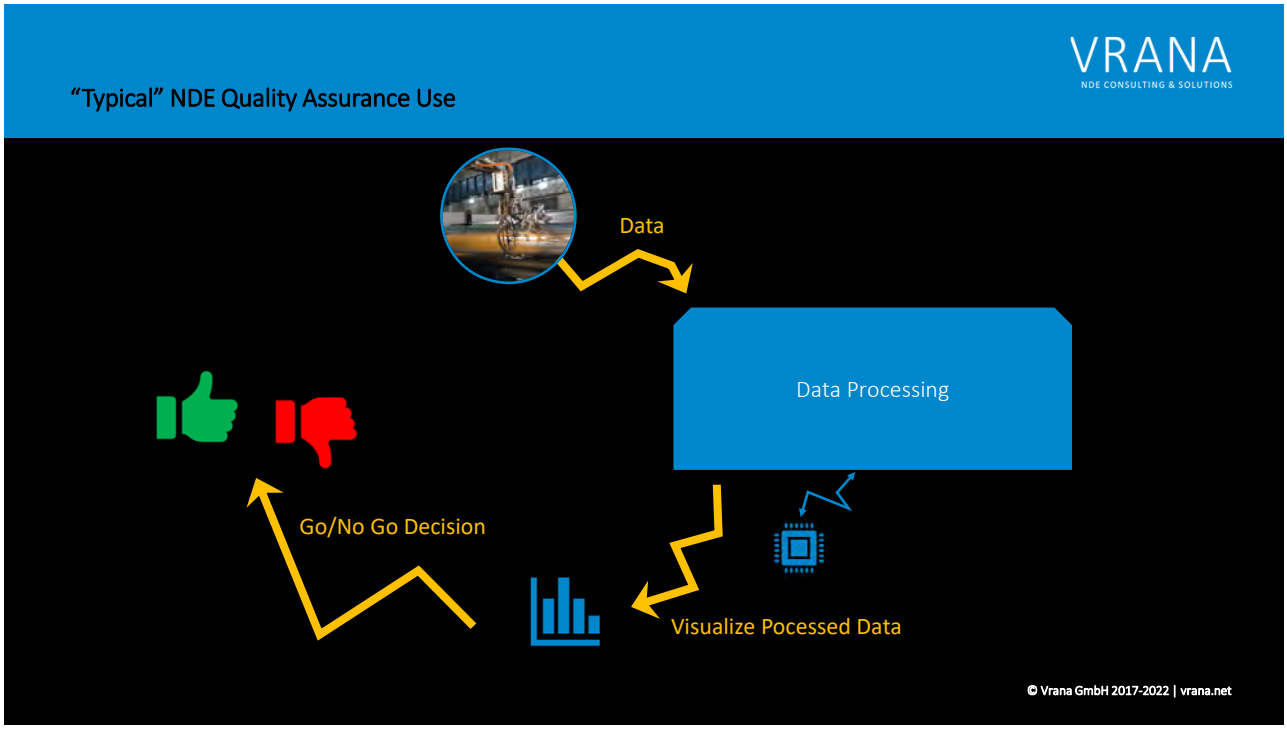

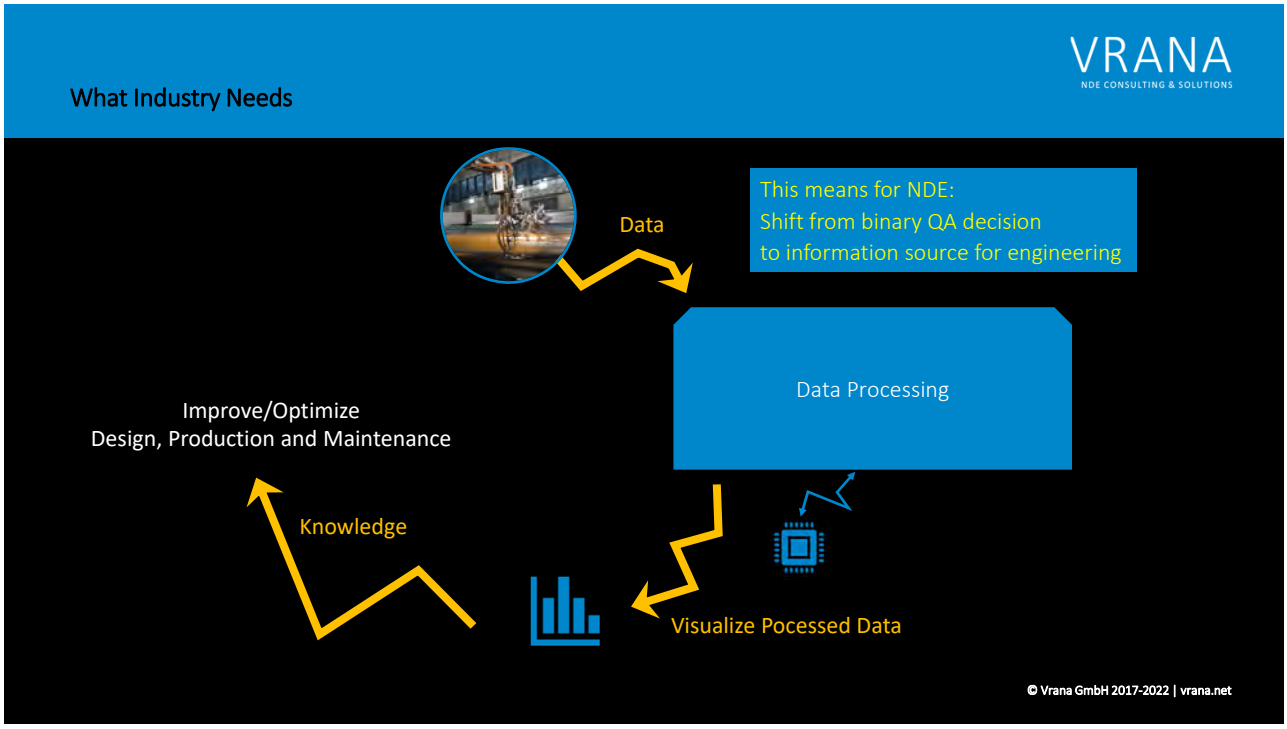

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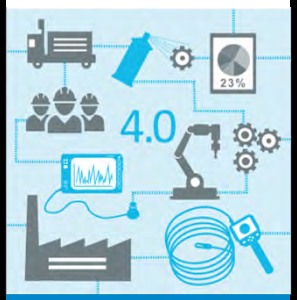
Industrial Internet of Things

NDE acting as a data source for Industry 4.0



Industry 4.0 for NDE

NDE for Industry 4.0

https://youtu.be/tB0nwxdyWZE

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Digital Transformation is a Journey

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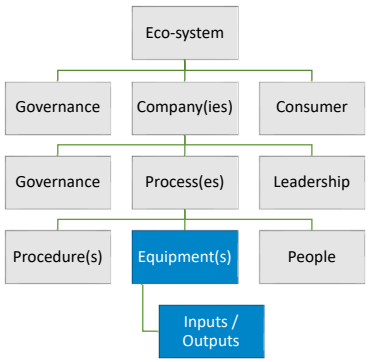
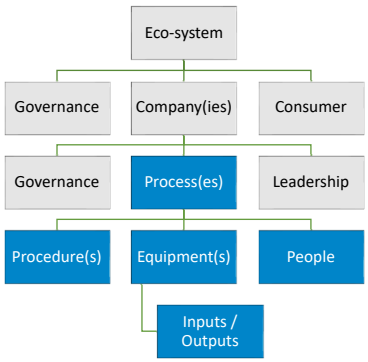
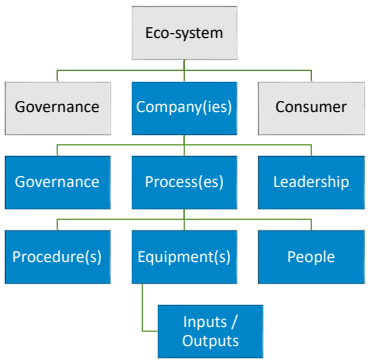
Digitize



Digitalize



Digitally Transform



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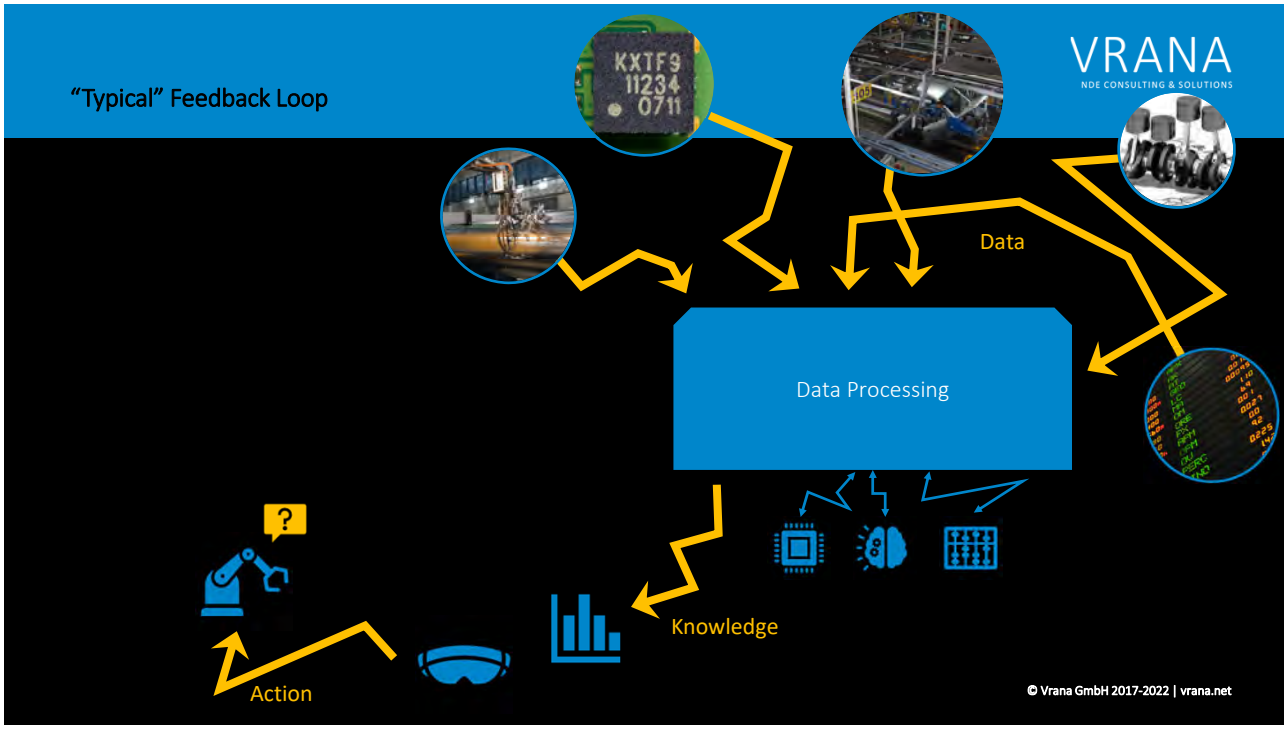

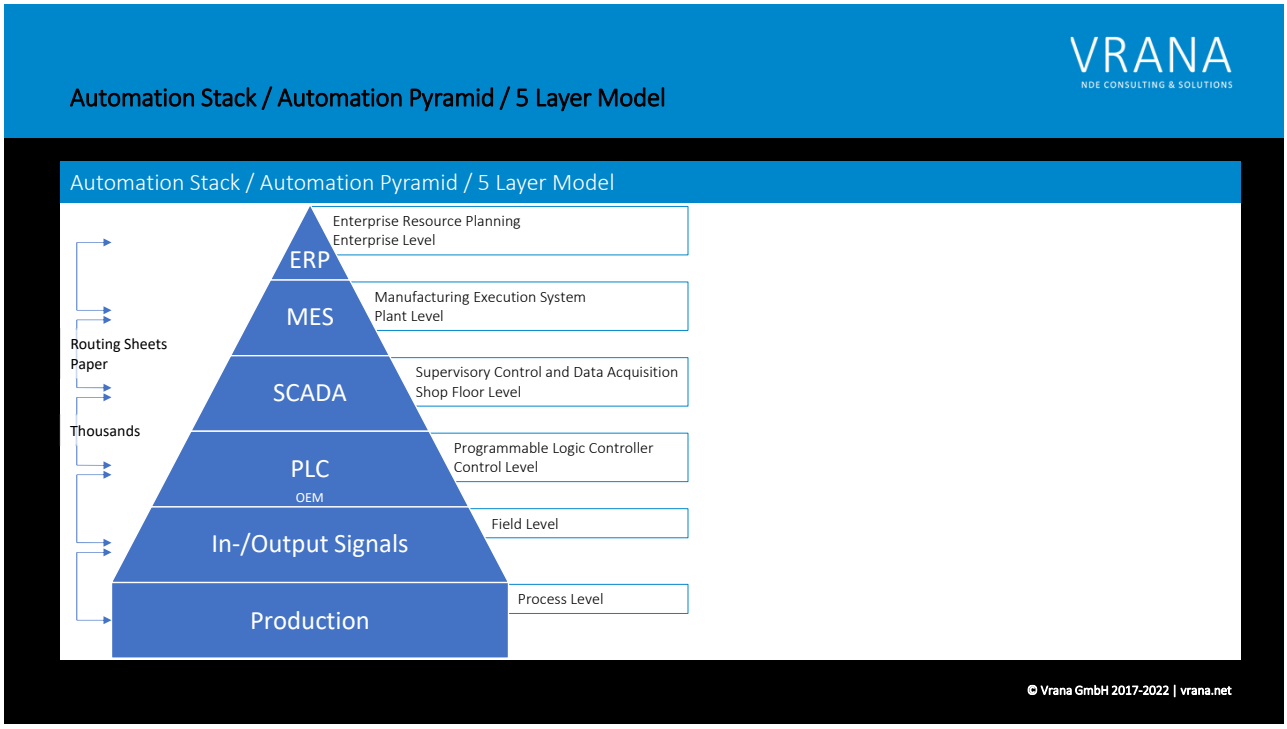

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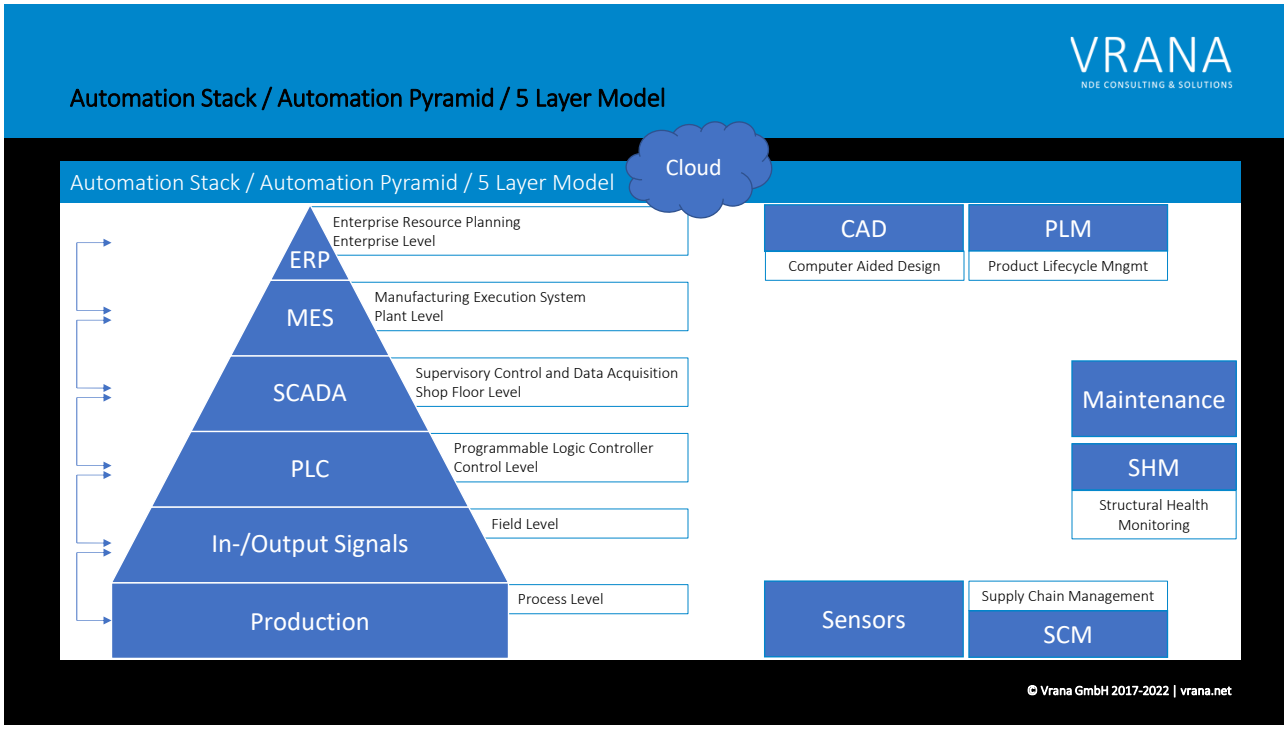

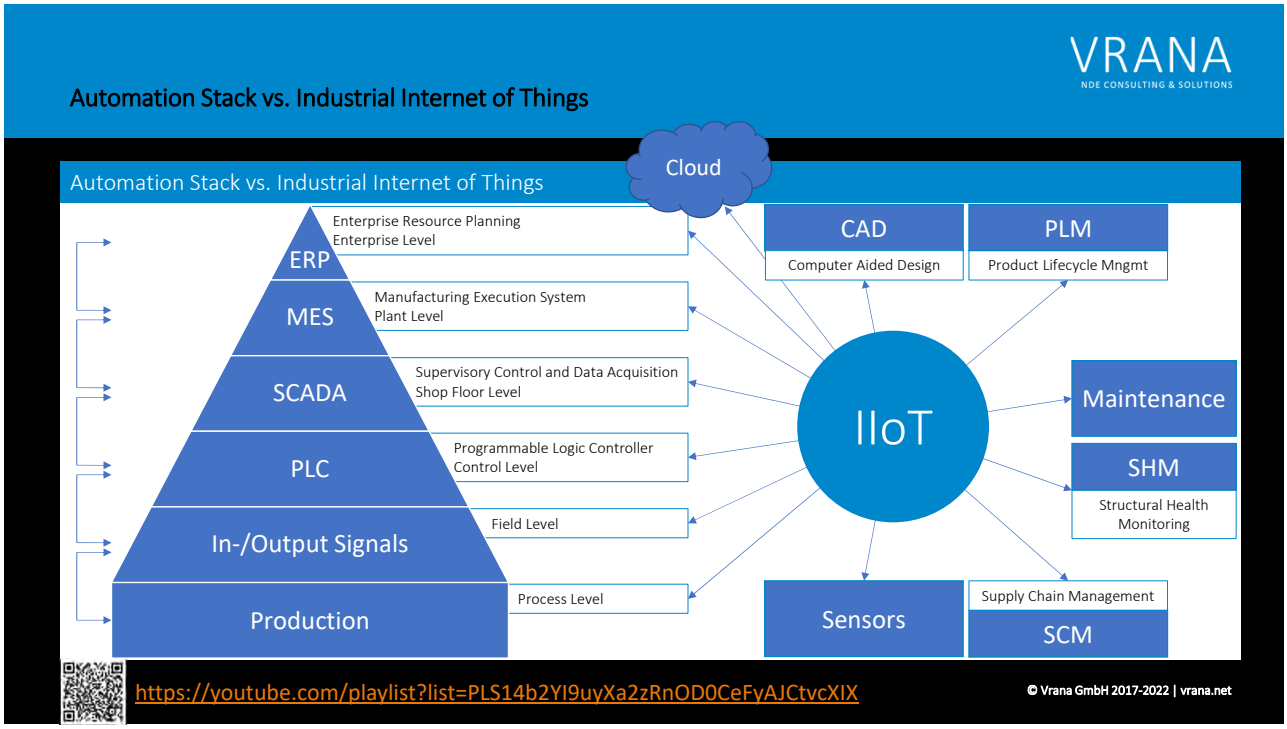

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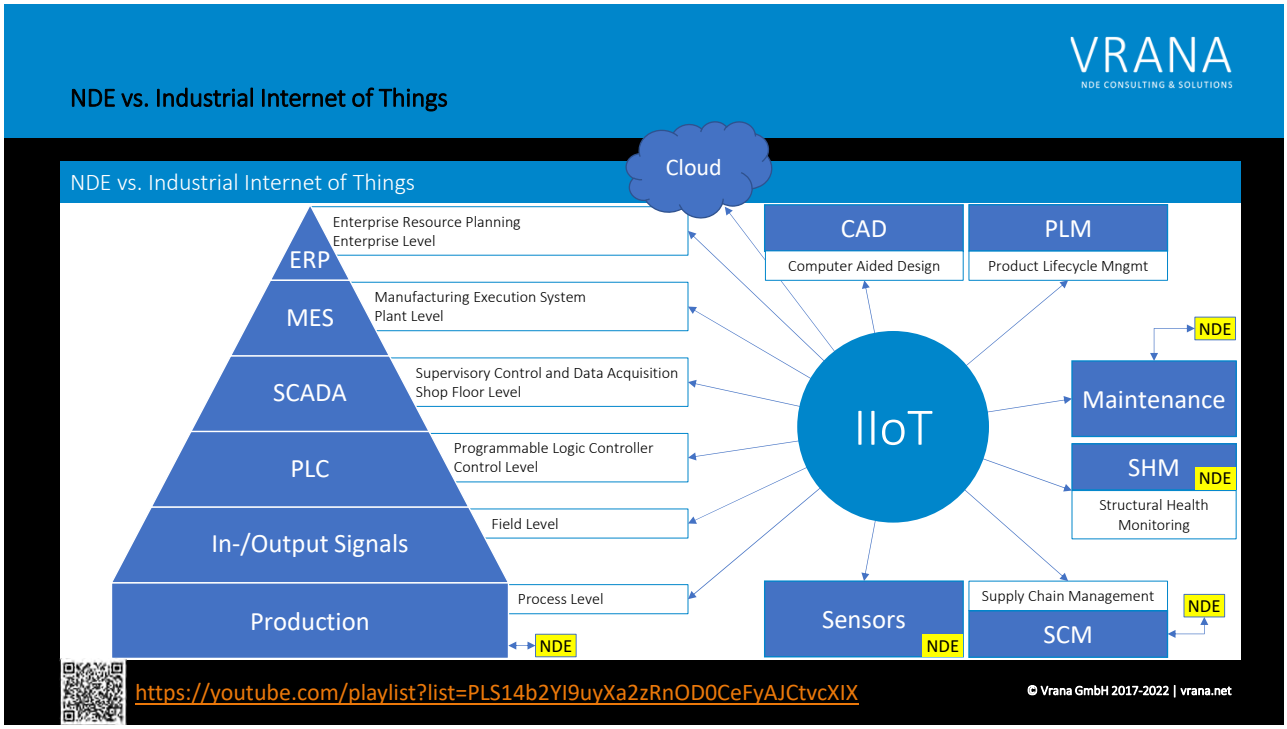

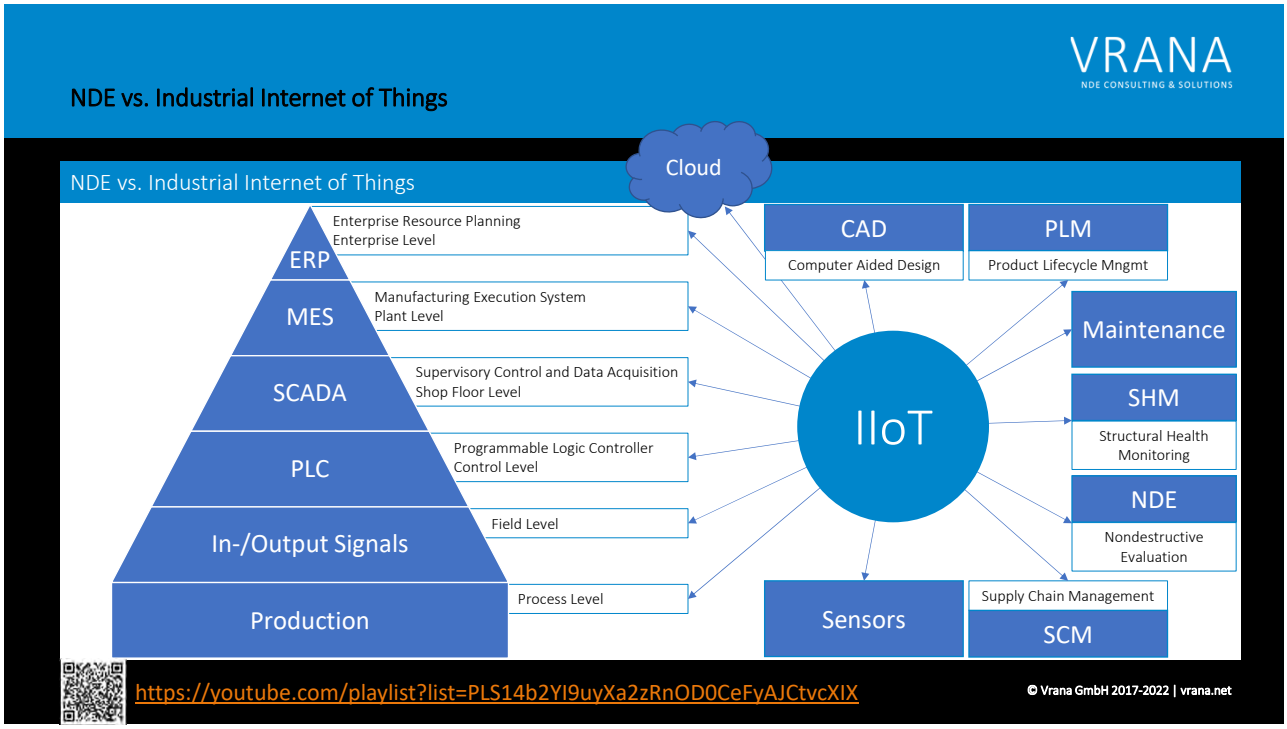

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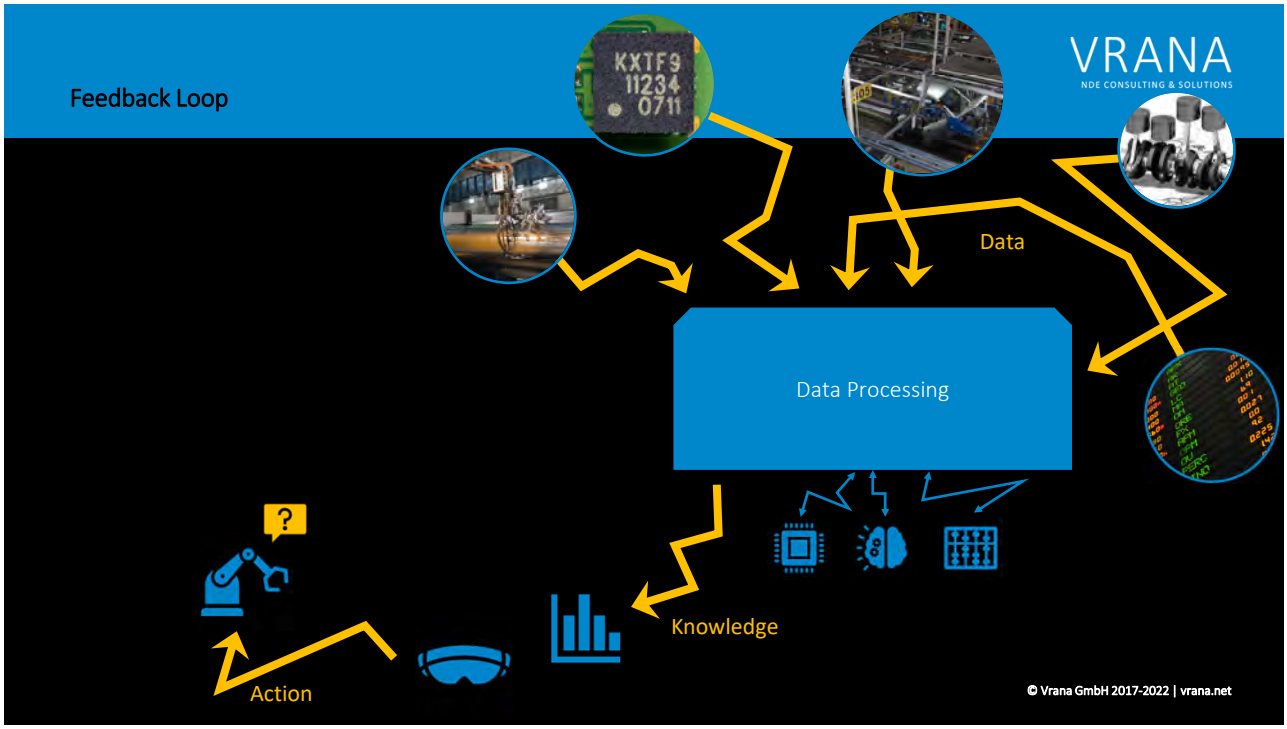

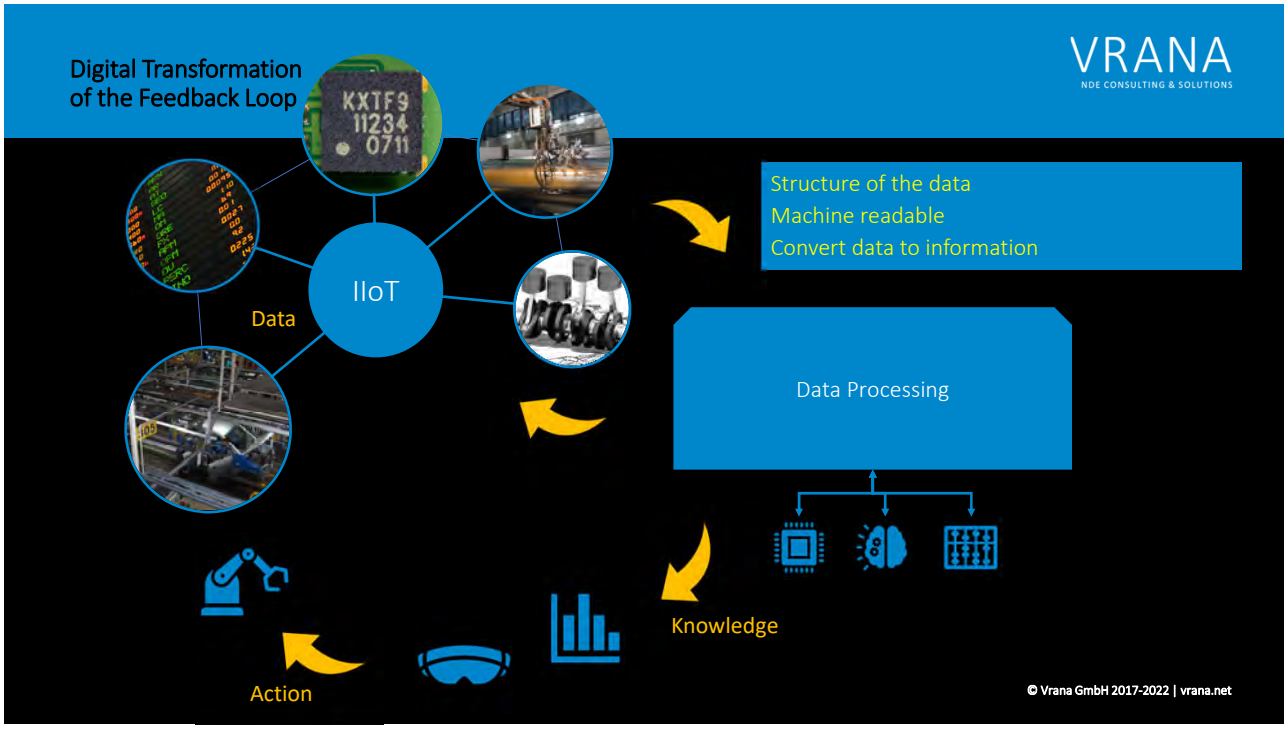

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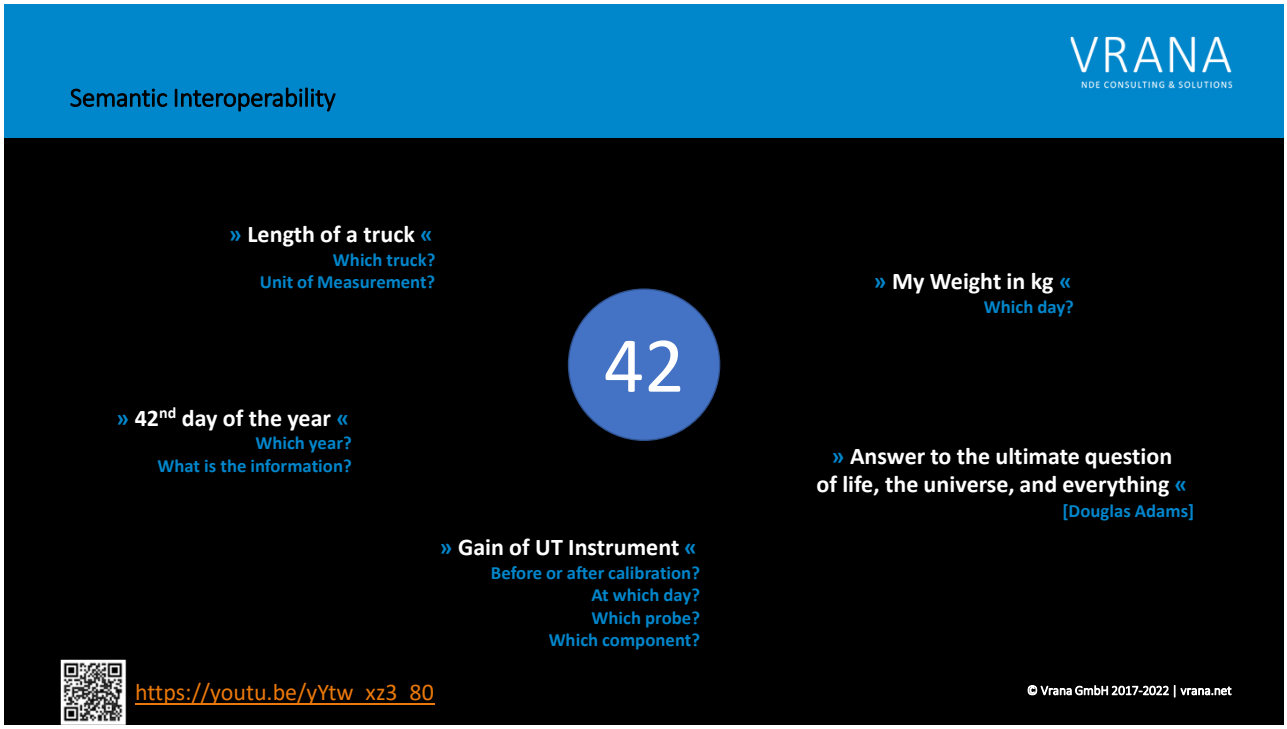

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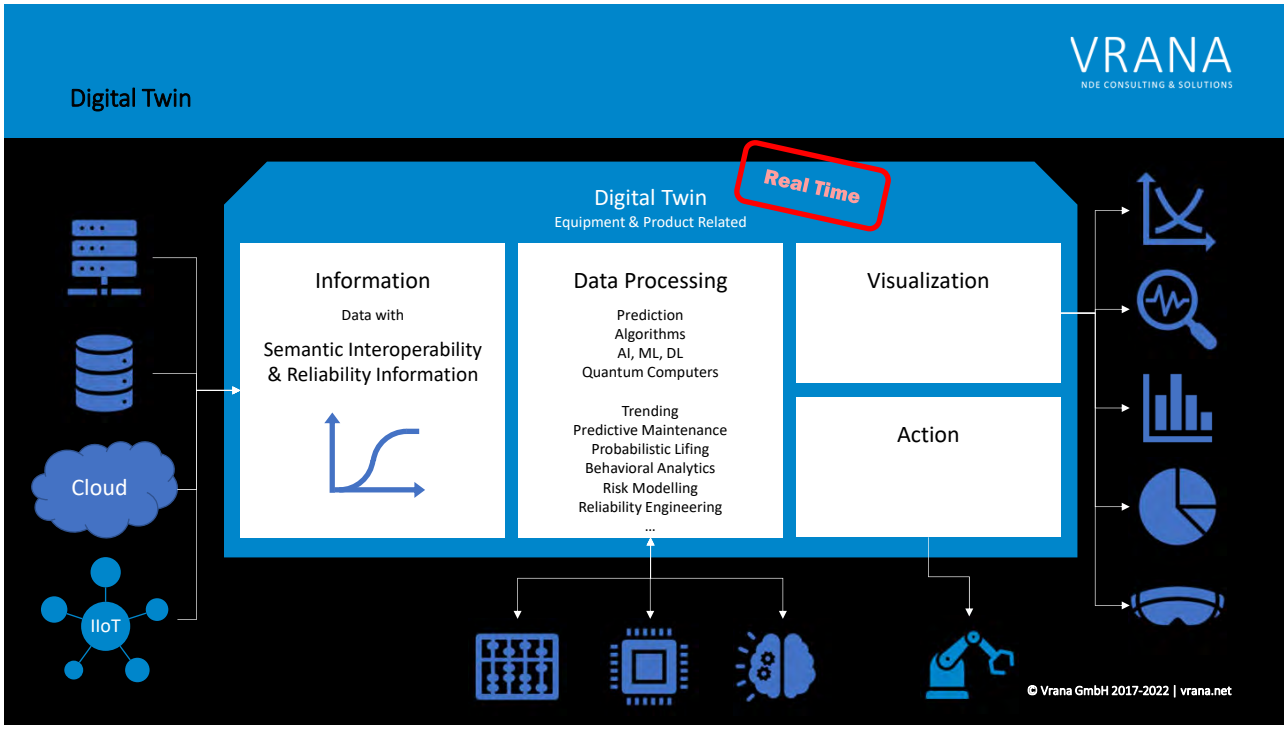

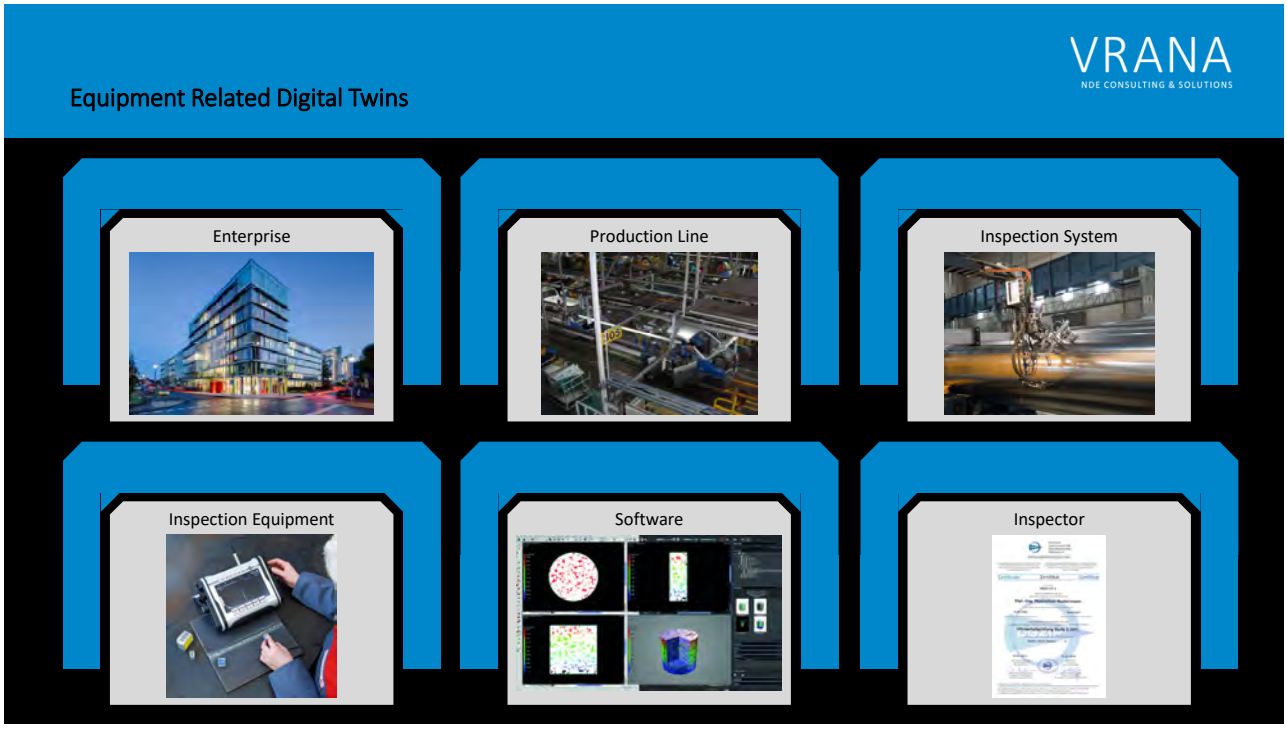

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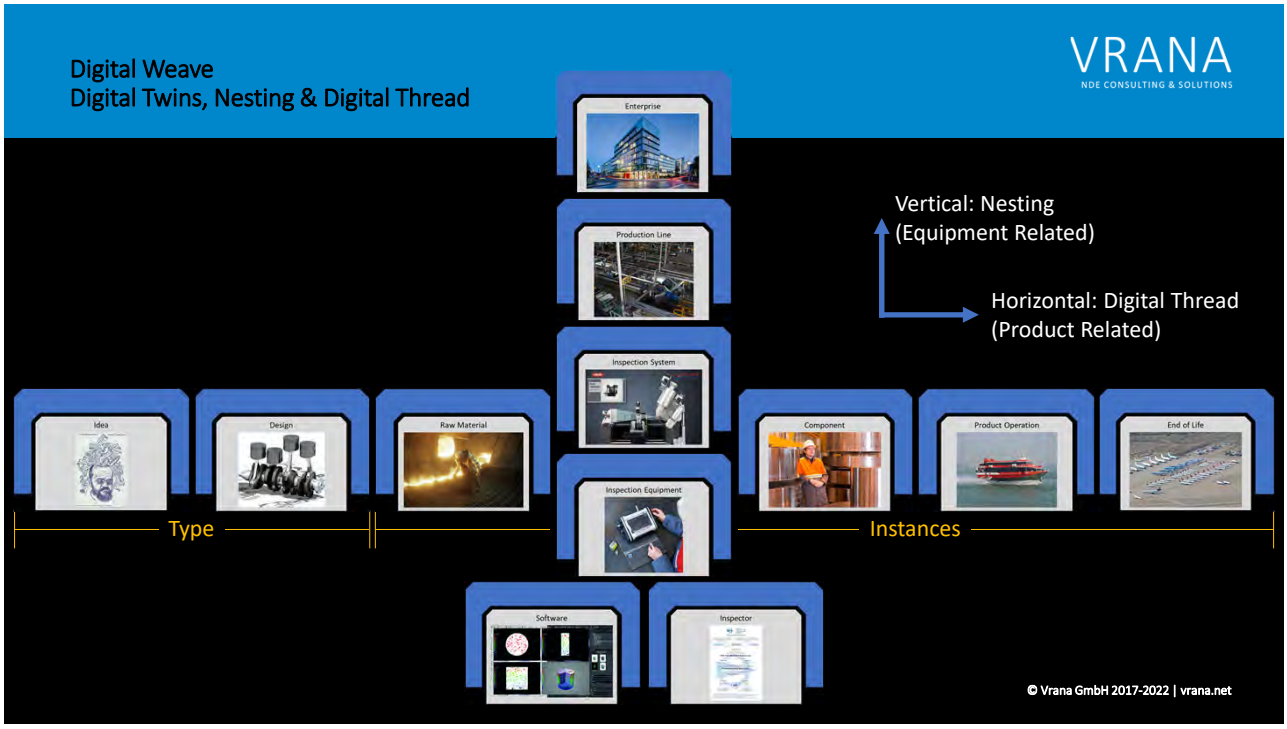

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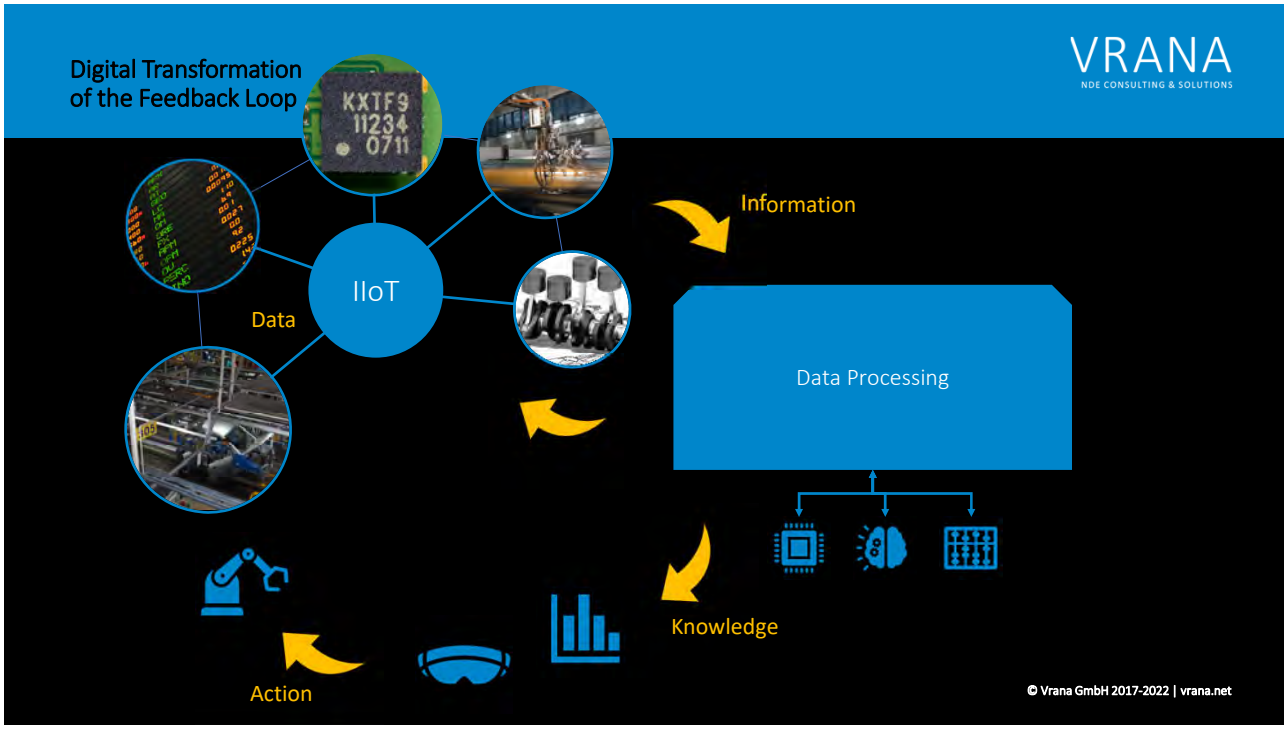

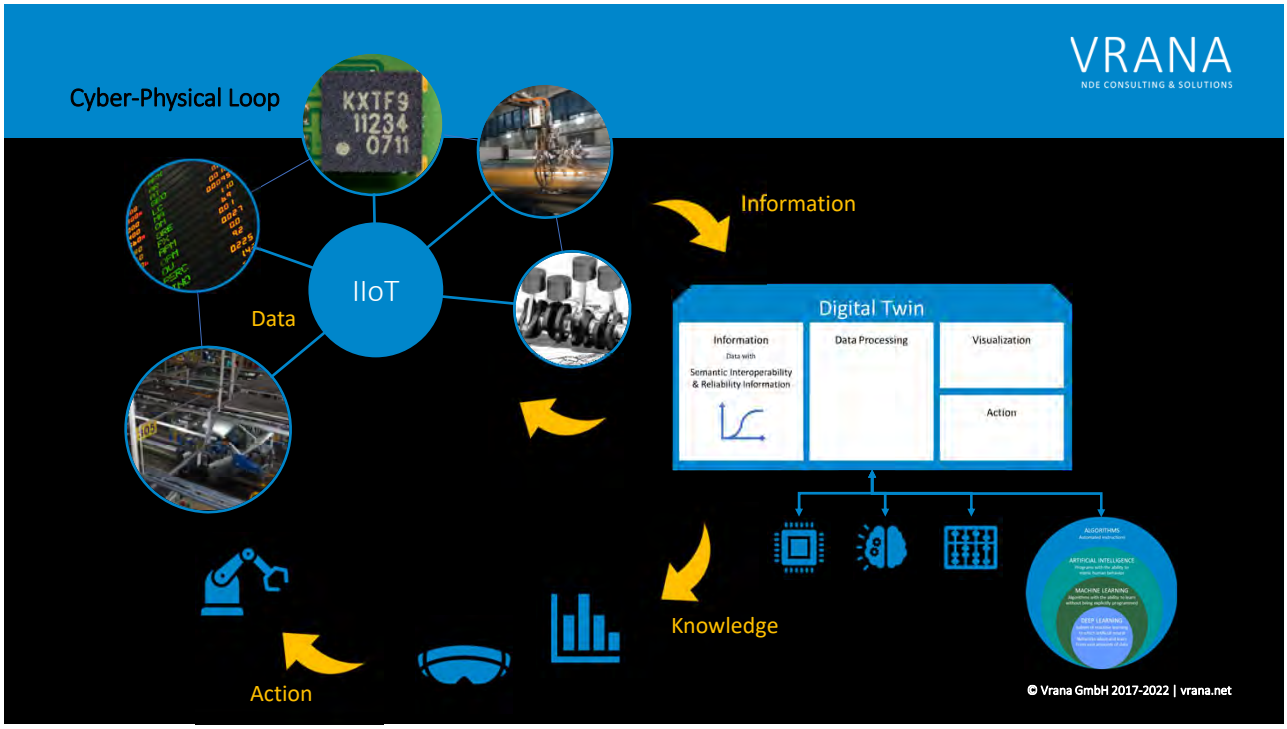

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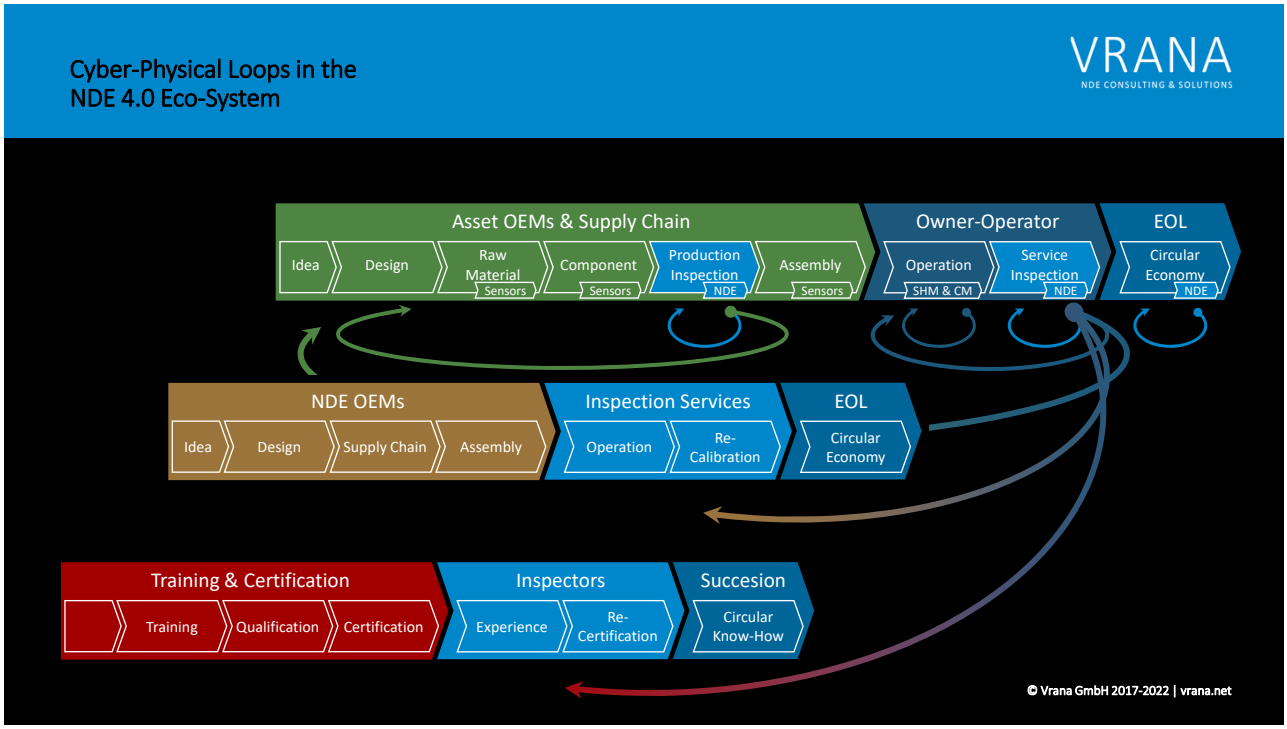

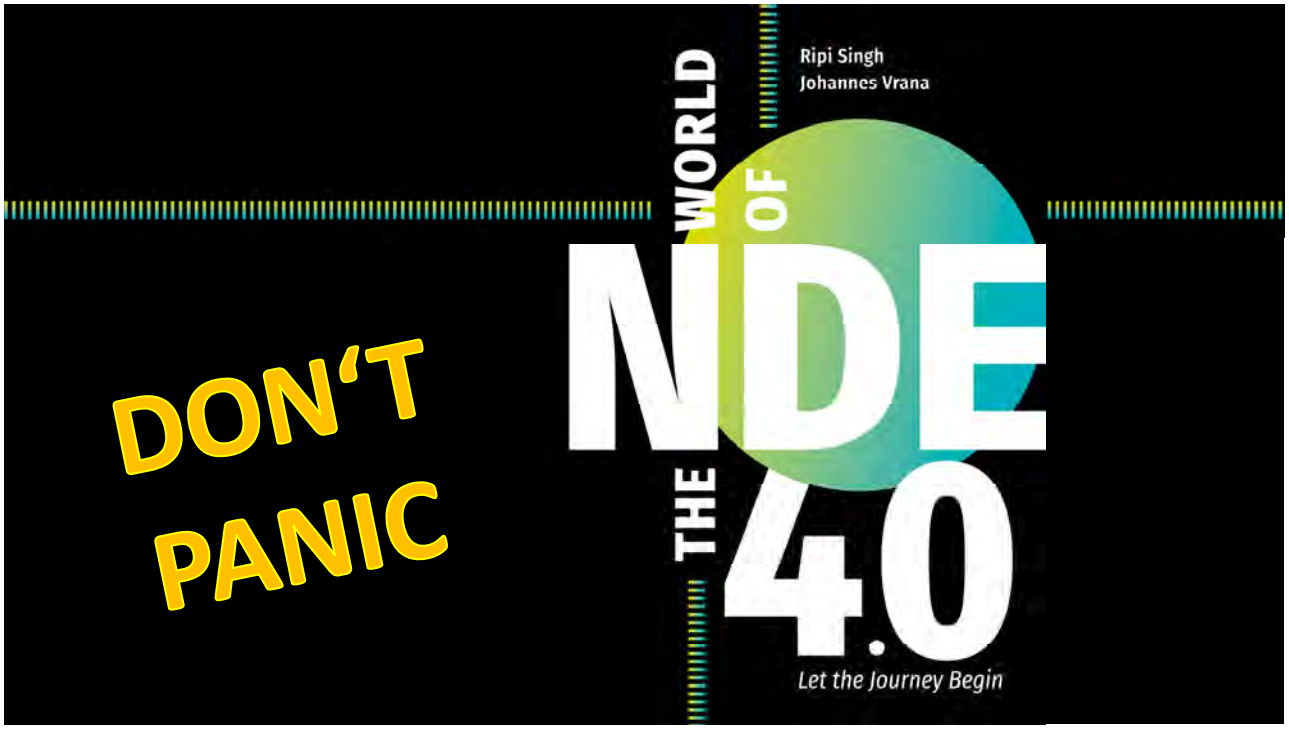

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Comments

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~~» Unnecessary Cost Factor «~~

» NDE: Data Treasure for Industry 4.0 «

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4 Pillars of Data Transparency

VRANA
NDE CONSULTING & SOLUTIONS

Data Transparency

Standardized **open** and well-documented data formats and interfaces	Data formats and interfaces with a **semantic interoperability** based on standardized information models	Data **security**	Data **sovereignty**

https://youtu.be/ptdHnT5evyQ & https://youtu.be/JEaZfwOlIHE

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TOC

Outline

Define
- *How do we define the generations of NDE ?*
  - *Ability to see what was unthinkable before*

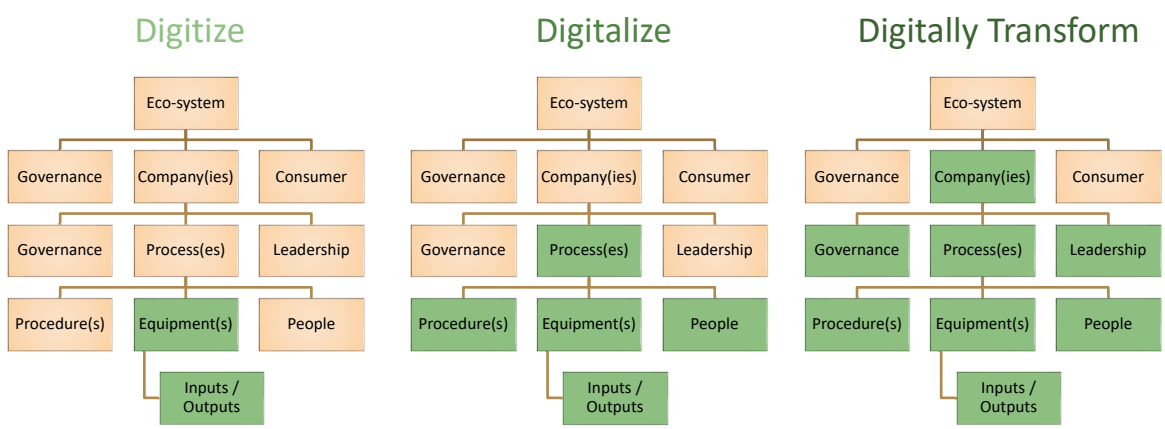
WHY
- *Why should we care for NDE 4.0 ?*
  - *Take maintenance value proposition to the next level - prescriptive maintenance*

WHAT
- *What is the technical magic under the hood ?*
  - *Digital Technologies with semantic interoperability*

HOW
- *How do you create a robust roadmap ?*

View

Digital Transformation is a Journey – Define the SCOPE



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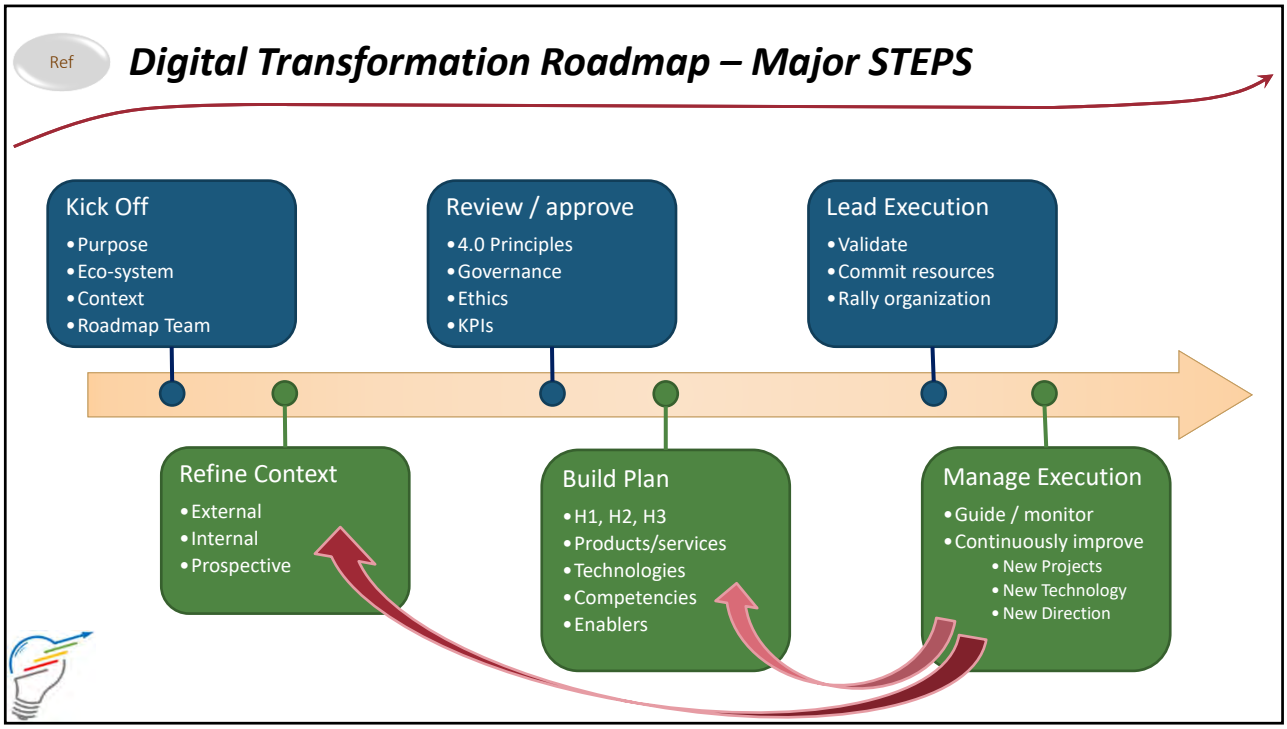

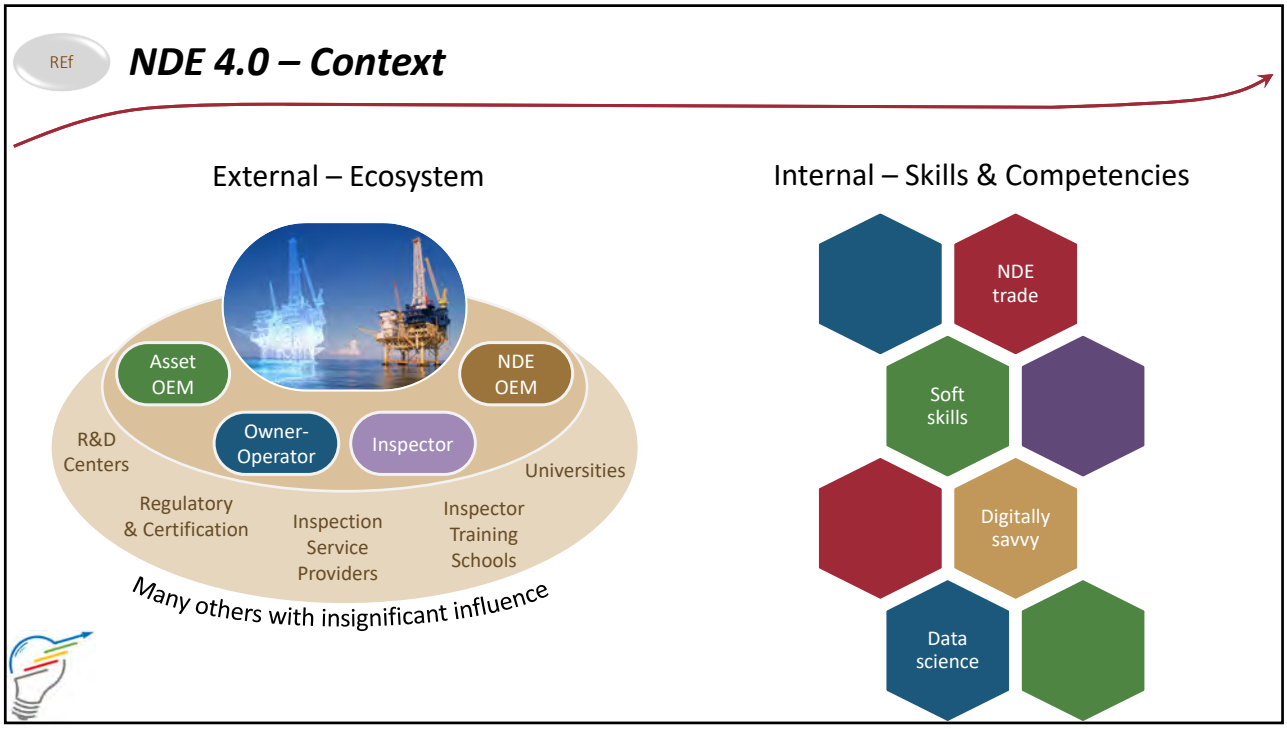

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Ref

Reference – NDE 4.0 Principles to Consider

Interoperability	•The ability of assets, instruments, sensors, devices, inspection equipment, and people to connect and communicate with each other via (IOT)
Information transparency	•The ability of assets and inspection systems to share information (data with semantic interoperability), facilitating interpretation, training, and visualization.
Technical assistance	•The ability of assets to assist in workflow management, inspection automation, and traceability
Decentralized decisions	•The ability of automated cyber physical inspection systems and assets to make decisions on their own and perform inspection tasks independently; or to seek human intervention in the case of exceptions, interferences, or conflicting goals.
Virtualization	•The ability of assets to generate virtual models of themselves and of other assets in their environment that facilitate generation of digital-twins.
Real Time	•The ability of assets to generate datasets that may be retrieved in real time to support and substantiate decentralized decision-making processes.
Modularity	•The ability and design characteristics of assets to flexibly adapt to different requirements.
Product-Service Offering	•The ability of NDE 4.0 solutions to synergistically merge products and services to create, capture and distribute substantially enhanced value in order to achieve the purpose of NDE 4.0

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WHAT
- *What is the technical magic under the hood?*
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HOW
- *How do you create a robust roadmap ?*
  - *Planned Journey – Mix of exploration, exploitation, and continuous adjustment*

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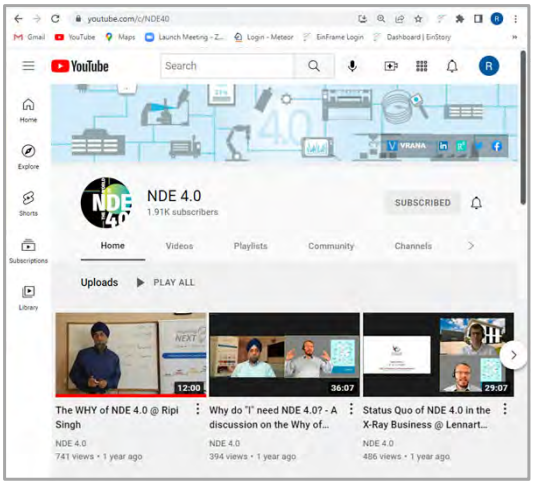
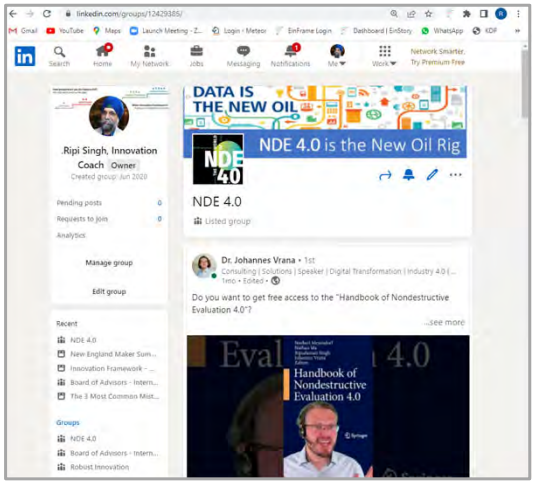
Free

NDE 4.0 YouTube Channel, LinkedIn Group – Free to join

~2000 Subscribers

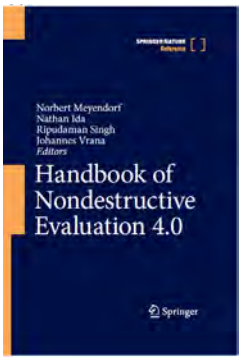


~200 Members

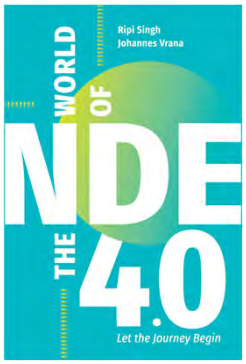


Ref

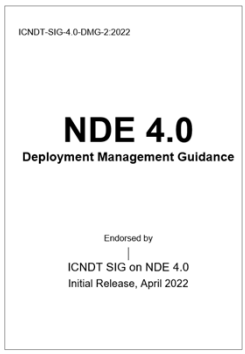
Useful Resources



~100 Contributors
10 Countries
45 Chapters
~1300 Pages



275 Pages
For Leaders



30 Pages, ISO Style

NDE Outlook
New column
Since Jan 2022

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Model

Selfie – NDE 4.0 is here, Who should you hire ?

Be the Leader

Chief Innovation Officer

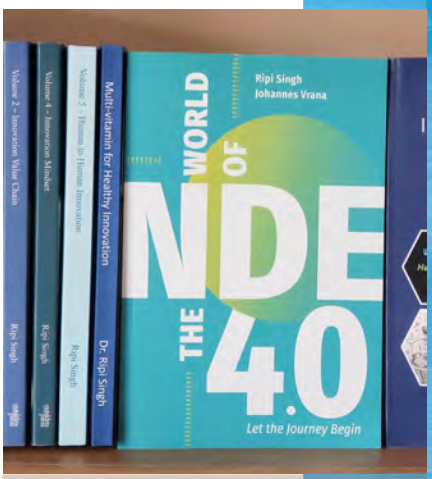
Follow the Leader

Chief Risk Officer

Observer

ASNT | LEARN.
GROW YOUR KNOWLEDGE. GROW YOUR CAREER.

For full Details



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